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(54) PRODUCTION OF MEMBER MADE OF MAGNESIUM ALLOY

(57)Abstract:
PURPOSE: To produce a member improved in forgeability and furthermore excellent in mechanical properties by allowing magnesium compounds present in the structure of a forging blank made of a magnesium alloy into solid solution and thereafter executing forging.
CONSTITUTION: A forging blank made of a magnesium alloy is subjected to forging and is subjected to heating treatment at 400 to 450° C for about ·10hr to enter magnesium compounds present in the structure of the forging blank into solid solution. Next, it is subjected to warm forging at about 300 to 380° C and is cooled to room temp., and deburring is executed. After that, it is subjected to aging treatment at about 162 to 210° C for about 16hr and is air- cooled. Furthermore, it is subjected to machining and is thereafter subjected to rust preventing treatment to produce a member made of a magnesium alloy. In this way, the member improved in forgeability and excellent in mechanical properties can be obtd.

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CLAIMS

[Claim(s)]
[Claim 1] The manufacture technique of the member made from a Magnesium alloy equipped with the forging process which carries out the forging molding of the forging blank after the heat-treatment process which makes the magnesium compound which exists in the process which obtains the forging blank made from a Magnesium alloy, and the above-mentioned process subsequently to the in-house of the above-mentioned forging blank dissolve, and the above-mentioned heat-treatment process.
[Claim 2] The heat-treatment in the above-mentioned heat-treatment process is the manufacture technique of the member made from a Magnesium alloy according to claim 1 that an aging treatment is given after the above-mentioned forging process while serving as solution treatment.
[Claim 3] The heat-treatment in the above-mentioned heat-treatment process is the manufacture technique of the member made from a Magnesium alloy according to claim 1 or 2 processed at the heating temperature of 400-450 degrees C.
[Claim 4] The manufacture technique of the member made from a Magnesium alloy according to claim 1, 2, or 3 of adjusting the temperature of the above-mentioned forging blank to warm-forging temperature after the above-mentioned heat-treatment succeeding this heat-treatment, and performing a warm forging.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the manufacture technique of the members made from a Magnesium alloy, such as a wheel and an upper arm of a suspension, used as autoparts.

[0002]

[Description of the Prior Art] Conventionally, there is the forging technique which is shown in drawing 7 among the technique of manufacturing the member made from a Magnesium alloy for the purpose of large lightweight-izing of parts. Namely, the bending of the material made from a Magnesium alloy (the so-called blank) is carried out at the 1st process 71. Perform buster forging at the following process [2nd] 72, and blocker forging is performed at the following process [3rd] 73. It is the manufacture technique of performing finisher forging at the following process [4th] 74, heat-treating T6 processing etc. at the following process [5th] 75, machining in the last configuration of parts at the following process [6th] 76, and performing rustproof processing at the following process [7th] 77. Thus, giving the forging processes 72, 73, and 74 covering several steps story forges by dividing into several steps story in the reason whose above-mentioned Magnesium alloy is difficulty plastic-working material, and a comparatively small working ratio.

[0003] However, although crystal grain forged by making it big and rough, there was a trouble where the enhancement in an intensity did not accept on the relation by which heating and cooling are repeated for every forging in such conventional technique. moreover, much forging — in needing metal mold, there was a trouble where consumption heat energy also served as size extremely

[0004] In order to solve such a trouble, the casting forging technique which is shown in drawing 8 is already invented conventionally. That is, while the blank made from a Magnesium alloy (forging blank) is manufactured by casting at the 1st process 81 and a forging blank is cooled at the following process [2nd] 82, trimming of the gate is carried out if needed, finisher forging is performed at the following process [3rd] 83, solution treatment is performed at the following process [4th] 84 after this finisher forging end, and artificial-aging processing is performed at the following process [5th] 85. It is the casting forging technique of machining in the last configuration of parts at the following process [6th] 86 after T6 processing end by each above-mentioned processes 84 and 85, and performing rustproof processing at the following process [7th] 87.

[0005] According to this conventional technique, the repeat count of heating and cooling is reduced by curtailment of the number of forging processes. While there is an advantage which can carry out as much as possible prevention of the big-and-rough-izing of the crystal grain of the member made from a Magnesium alloy Since the magnesium compound as an intermetallic compound carried out a segregation (segregation) to the in-house of the forging blank obtained by casting at the 1st above-mentioned process 81 and a crack occurred from the segregation part of this magnesium compound at the time of forging, there was a trouble where a forging moldability was bad.

[0006] On the other hand as the manufacture technique of the member made from a Magnesium alloy, Japanese Patent Application No. 268357 [three to] as these people's point

** is faced like a publication fabricating the material made from a Magnesium alloy (for example, wheel) by casting. By the technique of using the fraction (for example, rim section) by which forging molding (for example, spinning molding) is carried out at the time of casting, carrying out quenching processing of the chiller (chiller) etc. at a back process, and heating and carrying out forging formation of the quenching processing section after that, rapid solidification, although there is technique constituted so that detailed-ization of crystal grain might be attained This manufacture technique is for making a metal texture detailed, and no consideration to the segregation of a magnesium compound is made.

[0007]

[Problem(s) to be Solved by the Invention] After invention of this invention according to claim 1 makes the magnesium compound which exists in the in-house in the forging blank made from a Magnesium alloy dissolve, it aims at offer of the manufacture technique of the member made from a Magnesium alloy which can obtain the member which excelled [carry out / forging molding] in the mechanical property while the forging moldability was raised.

[0008] Invention of this invention according to claim 2 combines with the purpose of invention of the claim 1 above-mentioned publication, and aims at offer of the manufacture technique of the member made from a Magnesium alloy which can prevent big and rough-ization of crystal grain as compared with the technique of performing solution treatment after forging, by the heat-treatment which makes an above-mentioned magnesium compound dissolve serving as solution treatment.

[0009] Invention of this invention according to claim 3 combines with the purpose of invention the above-mentioned claim 1 or given in two, by setting the temperature requirement of above-mentioned heat-treatment as 400-450 degrees C, makes a magnesium compound fully dissolve and aims at offer of the manufacture technique of the member made from a Magnesium alloy which can perform good homogenization.

[0010] Invention of this invention according to claim 4 combines with the purpose of invention the above-mentioned claims 1 and 2 or given in three, by performing a warm forging succeeding an above-mentioned heat-treatment process, carries out the deployment of the heat energy at the time of heat-treatment to a warm-forging process, and aims at offer of the manufacture technique of the member made from a Magnesium alloy which can aim at a reduction of consumption heat energy.

[0011]

[Means for Solving the Problem] Invention of this invention according to claim 1 is characterized by being the manufacture technique of the member made from a Magnesium alloy equipped with the heat-treatment process which makes the magnesium compound which exists in the process which obtains the forging blank made from a Magnesium alloy, and the above-mentioned process subsequently to the in-house of the above-mentioned forging blank dissolve, and the forging process which carries out the forging molding of the forging blank after the above-mentioned heat-treatment process.

[0012] Invention of this invention according to claim 2 combines with the configuration of invention of the claim 1 above-mentioned publication, and it is characterized by the heat-treatment in the above-mentioned heat-treatment process being the manufacture technique of the member made from a Magnesium alloy that an aging treatment is given after the above-mentioned forging process, while serving as solution treatment.

[0013] Invention of this invention according to claim 3 combines with the configuration of invention the above-mentioned claim 1 or given in two, and heat-treatment in the above-mentioned heat-treatment process is characterized by being the manufacture technique of the member made from a Magnesium alloy processed at the heating temperature of 400-450 degrees C.

[0014] Invention of this invention according to claim 4 combines with the configuration of invention the above-mentioned claims 1 and 2 or given in three, the temperature of the above-mentioned forging blank is adjusted to warm-forging temperature after the above-mentioned heat-treatment succeeding this heat-treatment, and it is characterized by being the manufacture technique of the member made from a Magnesium alloy of performing a warm

forging.
[0015]
[Effect of the Invention] Since according to invention of this invention according to claim 1 forging molding is carried out after making the magnesium compound which exists in the in-house in the forging blank made from a Magnesium alloy at an above-mentioned heat-treatment process dissolve While **** of an intermetallic compound (magnesium compound) is sharply reduced by the above-mentioned dissolution and can, as a result, raise the forging moldability in a forging process It is effective in the ability to obtain the member made from a Magnesium alloy which was excellent in mechanical properties, such as tensile strength, elongation, and a rate of a marginal **** lump.
[0016] According to invention of this invention according to claim 2, as compared with the conventional technique of combining with the effect of the invention of the claim 1 above-mentioned publication, it not being necessary to perform solution treatment after forging since the heat-treatment which makes an above-mentioned magnesium compound dissolving serves as solution treatment, and performing solution treatment after forging for this reason, it is effective in the ability to prevent big and rough-ization of crystal grain. That is, although crystal grain will make it big and rough if above-mentioned solution treatment is an elevated temperature, and it is performed to artificial-aging processing after this hot solution treatment's forging, since solution treatment is performed before a forging process, big and rough-ization of such crystal grain can be prevented.
[0017] Since according to invention of this invention according to claim 3 it combined with the effect of the invention the above-mentioned claim 1 or given in two and the temperature requirement of above-mentioned heat-treatment was set as 400-450 degrees C, the magnesium compound ****ed by the in-house of a forging blank is made to fully dissolve, and it is effective in the ability to perform good homogenization.
[0018] Since according to invention of this invention according to claim 4 it combines with an effect of the invention the above-mentioned claims 1 and 2 or given in three and a warm forging is performed succeeding an above-mentioned heat-treatment process, the deployment of the heat energy of heat-treatment can be carried out to a warm-forging process, and, as a result, it is effective in the ability to aim at a reduction of consumption heat energy.
[0019]
[Example] One example of this invention is explained in full detail below based on a drawing. A drawing is the 1st process S1 of process drawing which showing the manufacture technique of the member made from a Magnesium alloy, and showing in drawing 1 , and carries out the casting molding of the forging blank made from a Magnesium alloy. Since the upper arm used for the suspension of an automobile as a member made from a Magnesium alloy is illustrated, the mold cavity approximated to the last configuration of an upper arm is formed, the molten metal of Magnesium alloy AZ80A of the composition shown below to this mold cavity in Table 1 is cast, and the **** forging blank 1 shown in drawing 2 is cast in this example.
[0020]
[Table 1]

成分	Al	Zn	Mn	Si	Cu	Ni	Fe	Mg
組成 (wt%)	8.2	0.56	0.18	0.02	0.001	0.001	0.002	Bal

[0021] Although it sets a die temperature as about 200 degrees C in using metal mold casting for an above-mentioned casting process, it can replace with this metal mold casting, and a sand-mold gravity-casting method, a die-casting method, a low pressure casting, and a half-melting injection-molding method can also be used. In addition, when above-mentioned metal mold casting is used, once cooling to ordinary temperature after casting of the forging blank 1, trimming of a riser fraction and a gate fraction is performed.
[0022] Next, heat-treatment which makes the magnesium compound which exists in the in-house of the forging blank 1 dissolve at the 2nd process S2 shown in drawing 1 is given. this

heat-treatment -- solution treatment -- serving -- heating temperature -- the domain of 400-450 degrees C -- it considers as about 410 degrees C desirably, and a heating time is made into 10 hours or more

[0023] All the magnesium compounds (specifically intermetallic compound of Mg-aluminum) that ****ed to the in-house of the forging blank 1 at the time of casting by giving above-mentioned heat-treatment which serves as such solution treatment dissolve, and the forging moldability in a back process is improved sharply.

[0024] next, the 3rd process S3 shown in drawing 1 -- the present temperature of 400-450 degrees C of the forging blank 1 -- the domain of 300-380 degrees C as warm-forging temperature -- it adjusts to 350 degrees C desirably Here, if warm-forging temperature exceeds 380 degrees C, since the front face of the forging blank 1 will oxidize, the upper limit of this temperature is made into 380 degrees C.

[0025] Next, if the warm forging (warm forging) of the above-mentioned forging blank 1 is carried out by 4th process S4 shown in drawing 1 using a punch and female mold, the member made from a Magnesium alloy 2 which is equivalent to the upper arm of the last configuration as shown in drawing 3 can be obtained. In addition, at this time, since a burr 3 (flash and thing of a flash plate) exists in the periphery of the above-mentioned member made from a Magnesium alloy 2, after cooling the member made from a Magnesium alloy 2 equipped with the burr 3 to a room temperature at the 5th process S5 shown in drawing 1 , deburring ** (trimming) is performed and it considers as the member made from a Magnesium alloy 2 which does not have a burr 3 as shown in drawing 4 .

[0026] Next, artificial-aging processing is performed to the above-mentioned member made from a Magnesium alloy 2 at the 6th process S6 shown in drawing 1 . That is, air cooling is performed after performing the domain of 165-210 degrees C, and according [set it as about 175 degrees C desirably, and] to this aging-treatment temperature low-temperature heating for aging-treatment temperature for about 16 hours.

[0027] Next, after machining a piercing etc. at the 7th process S6 shown in drawing 1 in the required part of the member made from a Magnesium alloy 2 after the above-mentioned aging treatment, rustproof processing is performed at the process S8 of the octavus shown in drawing 1 .

[0028] Thus, since forging molding is carried out after making the magnesium compound which exists in the in-house in the forging blank 1 made from a Magnesium alloy at an above-mentioned heat-treatment process (2nd process S2 reference) dissolve While **** of an intermetallic compound (it is a Mg-aluminum compound in the case of this example) is sharply reduced by the above-mentioned dissolution and can, as a result, raise the forging moldability in a forging process (refer to 4th process S4) It is effective in the ability to obtain the member made from a Magnesium alloy 2 which was excellent in mechanical properties, such as tensile strength, elongation, and a rate of a marginal **** lump.

[0029] Moreover, since the heat-treatment (2nd process S2 reference) which makes an above-mentioned magnesium compound dissolve serves as solution treatment It compares with the conventional technique of it not being necessary to perform solution treatment which applies high heat to a member 2 after forging, and performing solution treatment after forging for this reason. It is effective in the ability to prevent big and rough-ization of crystal grain, and the metal texture of T6 processing can be obtained by both processings with the solution treatment in the 2nd above-mentioned process S2, and artificial-aging processing in the 6th above-mentioned process S6.

[0030] Since the temperature requirement of heat-treatment was set as 400-450 degrees C, the magnesium compound in the 2nd further above-mentioned process S2 ****ed by the in-house of the forging blank 1 is made to fully dissolve, and it is effective in the ability to perform good homogenization.

[0031] In addition, since a warm forging is performed in 4th process S4 succeeding an above-mentioned heat-treatment process (2nd process S2 reference), the deformation resistance at the time of forging is small, and as well as scale generating becoming small, the deployment of the heat energy at the time of heat-treatment can be carried out to a warm-forging process,

and, as a result, it is effective in the ability to aim at a reduction of consumption heat energy.
[0032] In order to verify various above-mentioned effects, they are diameter 16mmphi and a product with a height of 24mm made from a Magnesium alloy (specifically AZ80A). The test piece which is two both whose diameters of initial average crystal grain of a material are 260 micrometers is beforehand cast under the same condition. After carrying out the warm forging of one ****** piece at the forging temperature of 350 degrees C, and 30% of the rates of a forging The comparison article which gave the aging treatment which carries out water cooling after performing solution treatment heated at about 400 degrees C for 15 hours, and carries out air cooling after heating at about 175 degrees C subsequently for 16 hours, After performing solution treatment which heats the test piece of another side at about 410 degrees C for 20 hours The example article which gave the aging treatment which carries out air cooling after carrying out a temperature control to about 350 degrees C, carrying out a warm forging at 30% of the rates of a forging and heating at about 175 degrees C for 16 hours is manufactured, respectively. The result which measured tensile strength, elongation, and the rate of a marginal **** lump to these comparisons article and the example article, respectively is shown in drawing 5 and the drawing 6 .
[0033] The tensile strength of an example article is improving to about 320 [MPa] to the thing with the as low tensile strength of a comparison article as about 300 [MPa] so that clearly from drawing 5 . Moreover, the elongation of elongation of an example article of a comparison article is improving to about 14% to about 10% and a low thing.
[0034] It turns out that the rate of a marginal **** lump of an example article is improving to about 70% to the thing with the as low rate of a marginal **** lump of a comparison article as about 60% so that still clearly from drawing 6 , and the moldability is improving. In addition, this rate of a marginal **** lump is expressed with the following several 1.
[0035]
[Equation 1]

$$\text{限界据え込み率} = \frac{Ho - H}{Ho} \times 100\ (\%)$$

ここにHoは据え込み前の高さ
Hは微少割れが生じた時の高さ
但し、H < Ho

[0036] In the configuration of this invention, and correspondence with an above-mentioned example, the process which obtains the forging blank of this invention It corresponds to the 1st process S1 of an example, and a heat-treatment process is equivalent to the 2nd process S2 like the following, a forging process corresponds to 4th process S4, and the process which gives an aging treatment is not limited only to the configuration of the example of a **** [** corresponding to the 6th process S6, and this invention].
[0037] For example, although the upper arm of the suspension of an automobile was illustrated as a member made from a Magnesium alloy in the above-mentioned example, of course, you may apply to the manufacture technique of a wheel or other members.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Process drawing showing the manufacture technique of the member made from a Magnesium alloy of this invention.
[Drawing 2] The perspective diagram of a forging blank.
[Drawing 3] The perspective diagram of the member made from a Magnesium alloy which has a burr after a warm forging.
[Drawing 4] The perspective diagram of the member made from a Magnesium alloy.
[Drawing 5] The property view showing the tensile strength elongation of an example article and a comparison article by comparison.
[Drawing 6] The property view showing the rate of a marginal **** lump of an example article and a comparison article by comparison.
[Drawing 7] Process drawing showing the manufacture technique of the conventional member made from a Magnesium alloy.
[Drawing 8] Process drawing showing the manufacture technique of the conventional member made from a Magnesium alloy.
[Description of Notations]
S1 -- The 1st process
S2 -- The 2nd process (heat-treatment process)
S3 -- The 4th process (forging process)
S6 -- The 6th process (aging-treatment process)
1 -- Forging blank
2 -- Member made from a Magnesium alloy

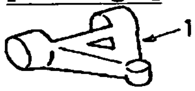
[Translation done.]

＊ NOTICES ＊

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

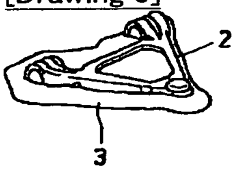
DRAWINGS

[Drawing 2]



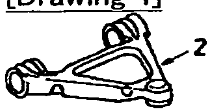
1… 鍛造ブランク

[Drawing 3]

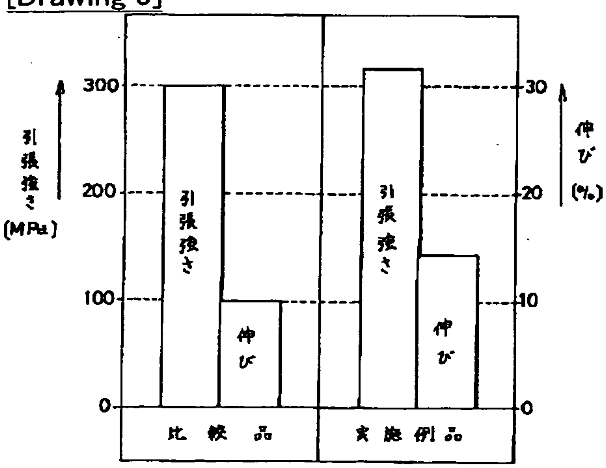


2…マグネシウム合金製部材

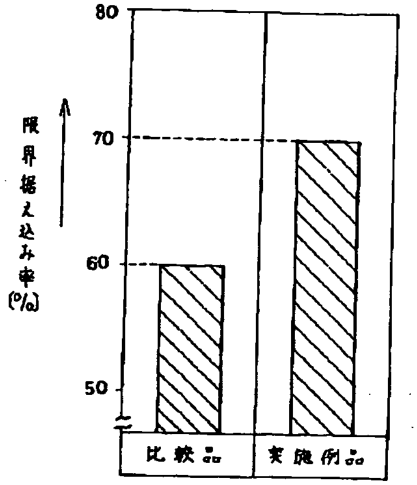
[Drawing 4]



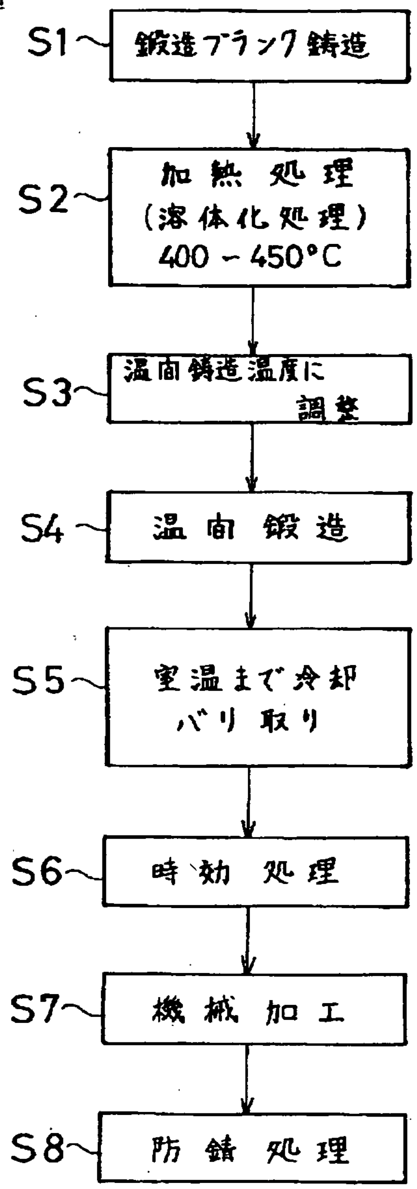
[Drawing 5]



[Drawing 6]

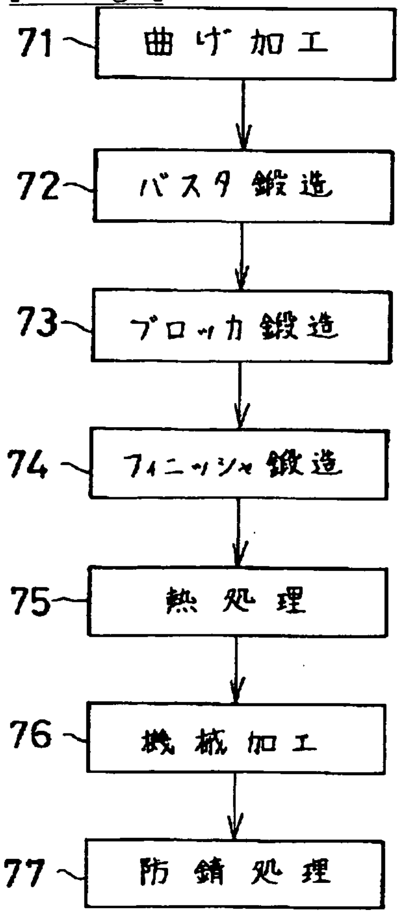


[Drawing 1]

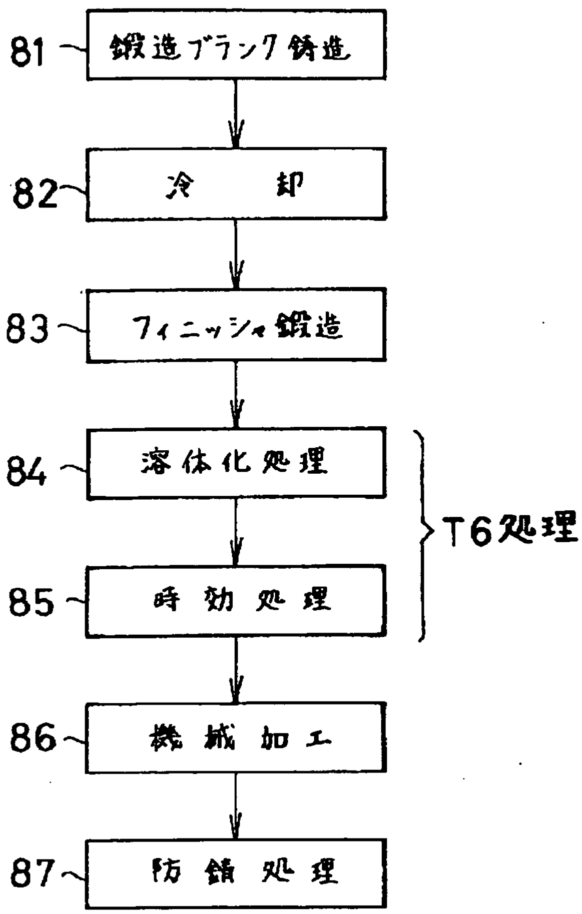


S1… 第1の工程（鋳造工程）　S2… 第2の工程（加熱処理工程）
S4… 第4の工程（鍛造工程）　S6… 第6の工程（時効処理工程）

[Drawing 7]



[Drawing 8]



[Translation done.]

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//Ｂ２１Ｋ	1/14	Ｚ	7047−4E		
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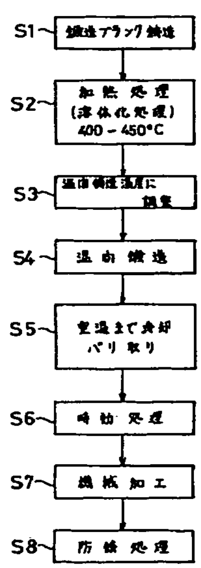
最終頁に続く

(54)【発明の名称】　マグネシウム合金製部材の製造方法

(57)【要約】

【目的】マグネシウム合金製の鍛造ブランクにおける組織内に存在するマグネシウム化合物を固溶させた後に、鍛造成形することで、鍛造成形性を向上させると共に、機械的性質の優れたマグネシウム合金製部材を得る。

【構成】マグネシウム合金製の鍛造ブランクを得る工程Ｓ１と、この工程Ｓ１に次いで鍛造ブランクの組織内に存在するマグネシウム化合物を固溶させる加熱処理工程Ｓ２と、この加熱処理工程Ｓ２の後に鍛造ブランクを鍛造成形する鍛造工程Ｓ４とを備えたことを特徴とする。



S1…第1の工程（鋳造工程）　S2…第2の工程（加熱処理工程）
S4…第4の工程（鍛造工程）　S6…第6の工程（時効処理工程）

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【特許請求の範囲】

【請求項１】マグネシウム合金製の鍛造ブランクを得る工程と、上記工程に次いで上記鍛造ブランクの組織内に存在するマグネシウム化合物を固溶させる加熱処理工程と、上記加熱処理工程の後に鍛造ブランクを鍛造成形する鍛造工程とを備えたマグネシウム合金製部材の製造方法。

【請求項２】上記加熱処理工程における加熱処理は溶体化処理を兼ねる一方、上記鍛造工程の後に時効処理が施される請求項１記載のマグネシウム合金製部材の製造方法。

【請求項３】上記加熱処理工程における加熱処理は４００～４５０℃の加熱温度で処理される請求項１または２記載のマグネシウム合金製部材の製造方法。

【請求項４】上記加熱処理の後、該加熱処理に連続して上記鍛造ブランクの温度を温間鍛造温度に調整して、温間鍛造を行なう請求項１，２または３記載のマグネシウム合金製部材の製造方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、例えば、自動車部品として用いられるホイールやサスペンションのアッパアーム等のようなマグネシウム合金製部材の製造方法に関する。

【０００２】

【従来の技術】従来、部品の大幅な軽量化を目的としてマグネシウム合金製部材を製造する方法には、例えば図７に示すような鍛造方法がある。すなわち、第１の工程７１でマグネシウム合金製の素材（いわゆるブランク）を曲げ加工し、次の第２の工程７２でバスタ鍛造を施し、次の第３の工程７３でブロッカ鍛造を施し、次の第４の工程７４でフィニッシャ鍛造を施し、次の第５の工程７５でＴ６処理等の熱処理を施し、次の第６の工程７６で部品の最終形状に機械加工し、次の第７の工程７７で防錆処理を施す製造方法である。このように数段階にわたる鍛造工程７２，７３，７４を施すのは、上述のマグネシウム合金が難塑性加工材である故、比較的小さい加工率にて数段階に分けて鍛造を施す。

【０００３】しかし、このような従来方法においては鍛造毎に加熱・冷却が繰返される関係上、結晶粒が粗大化し、鍛造を施したにもかかわらず強度の向上が認められない問題点があった。また多数の鍛造金型を必要とするうえ、消費熱エネルギも極めて大となる問題点があった。

【０００４】このような問題点を解決するため従来、図８に示すような鋳造鍛造方法が既に発明されている。すなわち、第１の工程８１で鋳造によりマグネシウム合金製のブランク（鍛造ブランク）を製造し、次の第２の工程８２で鍛造ブランクを冷却すると共に、必要に応じてゲートをトリミングし、次の第３の工程８３でフィニッシャ鍛造を施し、このフィニッシャ鍛造終了後において次の第４の工程８４で溶体化処理を施し、次の第５の工程８５で人工時効処理を施す。上述の各工程８４，８５によるＴ６処理終了後において、次の第６の工程８６で部品の最終形状に機械加工し、次の第７の工程８７で防錆処理を施す鋳造鍛造方法である。

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【０００５】この従来方法によれば、鍛造工程数の削減により、加熱、冷却の繰返し回数を低減して、マグネシウム合金製部材の結晶粒の粗大化を可及的防止することができる利点がある反面、上述の第１の工程８１で鋳造により得られた鍛造ブランクの組織内には金属間化合物としてのマグネシウム化合物が偏析（segregation ）し、鍛造時に、このマグネシウム化合物の偏析箇所から亀裂が発生するため、鍛造成形性が悪い問題点があった。

【０００６】一方、マグネシウム合金製部材の製造方法としては例えば本出願人の先願としての特願平３－２６８３５７号に記載の如く、鋳造でマグネシウム合金製素材（例えばホイール）を成形するに際して、後工程で鍛造成形（例えばスピニング成形）される部分（例えばリム部）を、鋳造時に冷し金（chiller ）等を用いて急冷処理し、その後、急冷処理部を加熱して鍛造形成する方法により急冷凝固によって結晶粒の微細化を図るように構成した方法があるが、この製造方法は金属組織を微細化するためのもので、マグネシウム化合物の偏析に対する考慮は一切なされていない。

【０００７】

【発明が解決しようとする課題】この発明の請求項１記載の発明は、マグネシウム合金製の鍛造ブランクにおける組織内に存在するマグネシウム化合物を固溶させた後に、鍛造成形することで、鍛造成形性を向上させると共に、機械的性質の優れた部材を得ることができるマグネシウム合金製部材の製造方法の提供を目的とする。

【０００８】この発明の請求項２記載の発明は、上記請求項１記載の発明の目的と併せて、上述のマグネシウム化合物を固溶させる加熱処理が溶体化処理を兼ねることで、鍛造後において溶体化処理を施す方法と比較して、結晶粒の粗大化を防止することができるマグネシウム合金製部材の製造方法の提供を目的とする。

【０００９】この発明の請求項３記載の発明は、上記請求項１または２記載の発明の目的と併せて、上述の加熱処理の温度範囲を４００～４５０℃に設定することで、マグネシウム化合物を充分に固溶させて、良好な均質化処理を行なうことができるマグネシウム合金製部材の製造方法の提供を目的とする。

【００１０】この発明の請求項４記載の発明は、上記請求項１、２または３記載の発明の目的と併せて、上述の加熱処理工程に連続して温間鍛造を行なうことで、加熱処理時の熱エネルギを温間鍛造工程に有効利用し、消費熱エネルギの低減を図ることができるマグネシウム合金

製部材の製造方法の提供を目的とする。

【００１１】

【課題を解決するための手段】この発明の請求項１記載の発明は、マグネシウム合金製の鍛造ブランクを得る工程と、上記工程に次いで上記鍛造ブランクの組織内に存在するマグネシウム化合物を固溶させる加熱処理工程と、上記加熱処理工程の後に鍛造ブランクを鍛造成形する鍛造工程とを備えたマグネシウム合金製部材の製造方法であることを特徴とする。

【００１２】この発明の請求項２記載の発明は、上記請求項１記載の発明の構成と併せて、上記加熱処理工程における加熱処理は溶体化処理を兼ねる一方、上記鍛造工程の後に時効処理が施されるマグネシウム合金製部材の製造方法であることを特徴とする。

【００１３】この発明の請求項３記載の発明は、上記請求項１または２記載の発明の構成と併せて、上記加熱処理工程における加熱処理は４００～４５０℃の加熱温度で処理されるマグネシウム合金製部材の製造方法であることを特徴とする。

【００１４】この発明の請求項４記載の発明は、上記請求項１、２または３記載の発明の構成と併せて、上記加熱処理の後、該加熱処理に連続して上記鍛造ブランクの温度を温間鍛造温度に調整して、温間鍛造を行なうマグネシウム合金製部材の製造方法であることを特徴とする。

【００１５】

【発明の効果】この発明の請求項１記載の発明によれば、上述の加熱処理工程でマグネシウム合金製の鍛造ブランクにおける組織内に存在するマグネシウム化合物を固溶させた後に、鍛造成形するので、金属間化合物（マグネシウム化合物）の偏折が上記固溶により大幅に低減され、この結果、鍛造工程での鍛造成形性を向上させることができると共に、引張強さ、伸び、限界据え込み率などの機械的性質の優れたマグネシウム合金製部材を得ることができる効果がある。

【００１６】この発明の請求項２記載の発明によれば、＊上記請求項１記載の発明の効果と併せて、上述のマグネシウム化合物を固溶させる加熱処理が溶体化処理を兼ねるので、鍛造後において溶体化処理を施す必要がなく、このため鍛造後において溶体化処理を施す従来方法と比較して、結晶粒の粗大化を防止することができる効果がある。すなわち上述の溶体化処理は人工時効処理に対して高温であり、この高温の溶体化処理が鍛造後に施されると結晶粒が粗大化するが、鍛造工程の前に溶体化処理を行なうので、このような結晶粒の粗大化を防止することができる。

【００１７】この発明の請求項３記載の発明によれば、上記請求項１または２記載の発明の効果と併せて、上述の加熱処理の温度範囲を４００～４５０℃に設定したので、鍛造ブランクの組織内に偏折されたマグネシウム化合物を充分に固溶させて、良好な均質化処理を行なうことができる効果がある。

【００１８】この発明の請求項４記載の発明によれば、上記請求項１、２または３記載の発明の効果と併せて、上述の加熱処理工程に連続して温間鍛造を行なうので、加熱処理の熱エネルギを温間鍛造工程に有効利用することができ、この結果、消費熱エネルギの低減を図ることができる効果がある。

【００１９】

【実施例】この発明の一実施例を以下図面に基づいて詳述する。図面はマグネシウム合金製部材の製造方法を示し、図１に示す工程図の第１の工程Ｓ１で、マグネシウム合金製の鍛造ブランクを鋳造成形する。この実施例ではマグネシウム合金製部材として自動車のサスペンションに用いられるアッパアームを例示しているので、アッパアームの最終形状に近似したキャビティを形成し、このキャビティに対して次に表１で示す組成のマグネシウム合金ＡＺ８０Ａの溶湯を鋳込んで、図２に示す如き鍛造ブランク１を鋳造する。

【００２０】

【表１】

成分	Al	Zn	Mn	Si	Cu	Ni	Fe	Mg
組成 (wt%)	8.2	0.56	0.18	0.02	0.001	0.001	0.002	Bal

【００２１】上述の鋳造工程に金型鋳造を用いる場合には、金型温度を約２００℃に設定するが、この金型鋳造に代えて、砂型重力鋳造法、ダイカスト鋳造法、低圧鋳造法、半溶融射出成形法を用いることもできる。なお、上述の金型鋳造を用いた場合には、鍛造ブランク１の鋳造後において一旦、常温まで冷却した後に、押し湯部分およびゲート部分のトリミングを行なう。

【００２２】次に図１に示す第２の工程Ｓ２で、鍛造ブランク１の組織内に存在するマグネシウム化合物を固溶させる加熱処理を施す。この加熱処理は溶体化処理を兼ね、加熱温度を４００～４５０℃の範囲、望ましくは約４１０℃とし、加熱時間を１０時間以上とする。

【００２３】このような溶体化処理を兼ねる上述の加熱処理を施すことで、鋳造時に鍛造ブランク１の組織内に偏折したマグネシウム化合物（具体的にはＭｇ－Ａｌの金属間化合物）は全て固溶し、後工程における鍛造成形性が大幅に改善される。

【００２４】次に図１に示す第３の工程Ｓ３で、鍛造ブ

ランク１の現行の温度４００～４５０℃を、温間鍛造温度としての３００～３８０℃の範囲、望ましくは３５０℃に調整する。ここで、温間鍛造温度が３８０℃を超過すると、鍛造ブランク１の表面が酸化するので、該温度の上限を３８０℃とする。

【００２５】次に図１に示す第４の工程Ｓ４で、上型および下型を用いて上述の鍛造ブランク１を温間鍛造（warm forging）すると、図３に示すように最終形状のアッパアームに相当するマグネシウム合金製部材２を得ることができる。なお、この時点では上述のマグネシウム合金製部材２の周縁にはバリ３（flash 、フラッシュのこと）が存在するので、図１に示す第５の工程Ｓ５で、バリ３を備えたマグネシウム合金製部材２を室温まで冷却した後に、バリ取り（トリミングのこと）を行なって、図４に示すようにバリ３のないマグネシウム合金製部材２とする。

【００２６】次に図１に示す第６の工程Ｓ６で上述のマグネシウム合金製部材２に人工時効処理を施す。すなわち時効処理温度を１６５～２１０℃の範囲、望ましくは約１７５℃に設定し、この時効処理温度による低温加熱を約１６時間行なった後に空冷を行なう。

【００２７】次に図１に示す第７の工程Ｓ６で、上記時効処理後のマグネシウム合金製部材２の必要箇所に穿孔加工などの機械加工を施した後に、図１に示す第８の工程Ｓ８で、防錆処理を施す。

【００２８】このように、上述の加熱処理工程（第２の工程Ｓ２参照）でマグネシウム合金製の鍛造ブランク１における組織内に存在するマグネシウム化合物を固溶させた後に、鍛造成形するので、金属間化合物（この実施例の場合はＭｇ－Ａｌ化合物）の偏折が上記固溶により大幅に低減され、この結果、鍛造工程（第４の工程Ｓ４参照）での鍛造成形性を向上させることができると共に、引張強さ、伸び、限界据え込み率などの機械的性質の優れたマグネシウム合金製部材２を得ることができる効果がある。

【００２９】また上述のマグネシウム化合物を固溶させる加熱処理（第２の工程Ｓ２参照）が溶体化処理を兼ねるので、鍛造後において部材２に高い熱を加える溶体化処理を施す必要がなく、このため鍛造後において溶体化処理を施す従来方法と比較して、結晶粒の粗大化を防止することができる効果があり、上述の第２の工程Ｓ２に＊おける溶体化処理と、上述の第６の工程Ｓ６における人工時効処理との両処理によりＴ６処理の金属組織を得ることができる。

【００３０】さらに上述の第２の工程Ｓ２での加熱処理の温度範囲を４００～４５０℃に設定したので、鍛造ブランク１の組織内に偏折されたマグネシウム化合物を充分に固溶させて、良好な均質化処理を行なうことができる効果がある。

【００３１】加えて、上述の加熱処理工程（第２の工程Ｓ２参照）に連続して第４の工程Ｓ４にて温間鍛造を行なうので、鍛造時の変形抵抗が小さく、スケール発生が僅少となることは勿論、加熱処理時の熱エネルギを温間鍛造工程に有効利用することができ、この結果、消費熱エネルギの低減を図ることができる効果がある。

【００３２】上述の各種効果を検証するために、直径１６mm$^{\phi}$ 、高さ２４mmのマグネシウム合金（具体的にはＡＺ８０Ａ）製で、素材の初期平均結晶粒径が共に２６０μmの２つのテストピースを予め同一条件下で鋳造し、一方のテイトピースを鍛造温度３５０℃、鍛造加工率３０％で温間鍛造した後に、約４００℃で１５時間加熱する溶体化処理を施した後に水冷し、次いで約１７５℃で１６時間加熱した後に空冷する時効処理を施した比較品と、他方のテストピースを約４１０℃で２０時間加熱する溶体化処理を施した後に、約３５０℃に温度調整し、鍛造加工率３０％で温間鍛造した後に、約１７５℃で１６時間加熱した後に空冷する時効処理を施した実施例品とをそれぞれ製造し、これら比較品および実施例品に対してそれぞれ引張強さ、伸び、限界据え込み率を測定した結果を図５、図６に示す。

【００３３】図５から明らかなように比較品の引張強さが約３００［ＭＰａ］と低いのに対して、実施例品の引張強さは約３２０［ＭＰａ］に向上している。また比較品の伸びが約１０％と低いのに対して、実施例品の伸びは約１４％に向上している。

【００３４】さらに図６から明らかなように比較品の限界据え込み率が約６０％と低いのに対して、実施例品の限界据え込み率は約７０％に向上しており、成形性が向上していることがわかる。なお、この限界据え込み率は次の数１で表される。

【００３５】

【数１】

$$\text{限界据え込み率} = \frac{H_0 - H}{H_0} \times 100\ (\%)$$

ここにHoは据え込み前の高さ
Hは微少割れが生じた時の高さ
但し、H ＜ Ho

【００３６】この発明の構成と、上述の実施例との対応において、この発明の鍛造ブランクを得る工程は、実施

例の第１の工程Ｓ１に対応し、以下同様に、加熱処理工程は、第２の工程Ｓ２に対応し、鍛造工程は、第４の工程Ｓ４に対応し、時効処理を施す工程は、第６の工程Ｓ６に対応するも、この発明は、上述の実施例の構成のみに限定されるものではない。

【００３７】例えば上記実施例においてはマグネシウム合金製部材として自動車のサスペンションのアッパアームを例示したが、ホイールやその他の部材の製造方法に適用してもよいことは勿論である。

【図面の簡単な説明】

【図１】本発明のマグネシウム合金製部材の製造方法を示す工程図。

【図２】鍛造ブランクの斜視図。

【図３】温間鍛造後のバリを有するマグネシウム合金製部材の斜視図。

【図４】マグネシウム合金製部材の斜視図。 ＊

＊【図５】実施例品と比較品との引張強さ伸びを対比して示す特性図。

【図６】実施例品と比較品との限界据え込み率を対比して示す特性図。

【図７】従来のマグネシウム合金製部材の製造方法を示す工程図。

【図８】従来のマグネシウム合金製部材の製造方法を示す工程図。

【符号の説明】

Ｓ１…第１の工程

Ｓ２…第２の工程（加熱処理工程）

Ｓ３…第４の工程（鍛造工程）

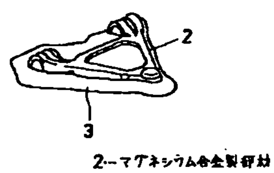
Ｓ６…第６の工程（時効処理工程）

１…鍛造ブランク

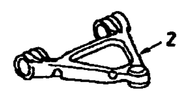
２…マグネシウム合金製部材

【図２】

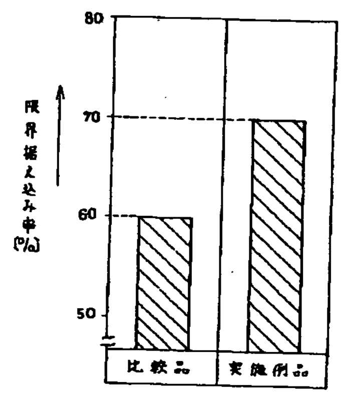
【図３】



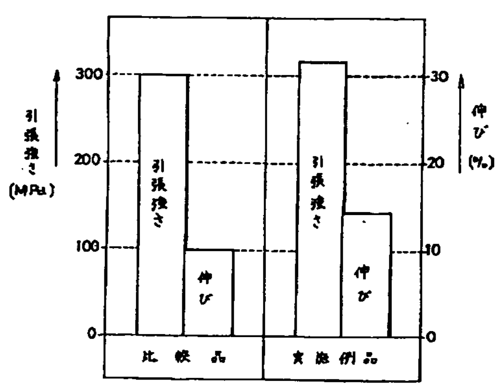
【図４】



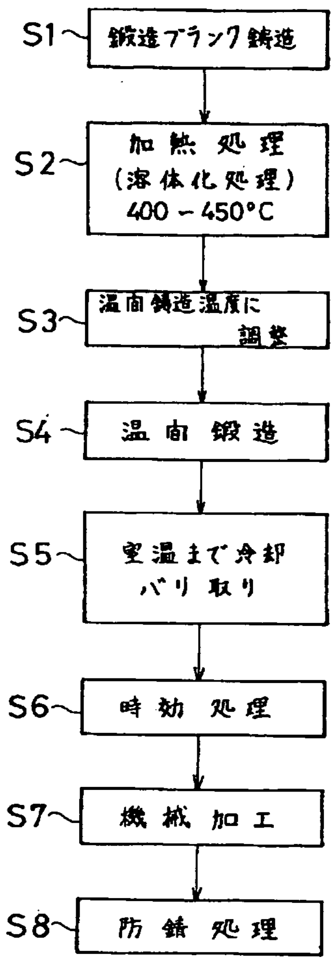
【図６】



【図５】

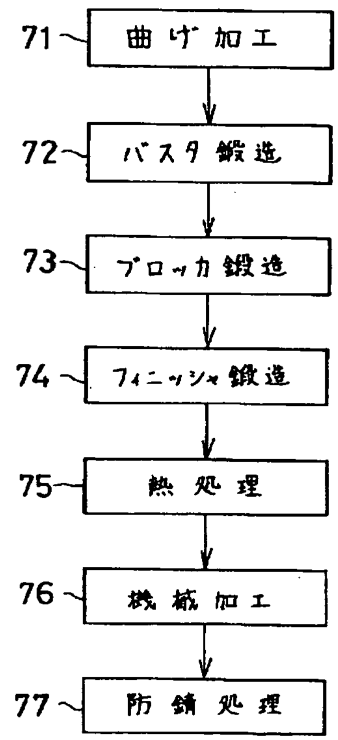


【図1】

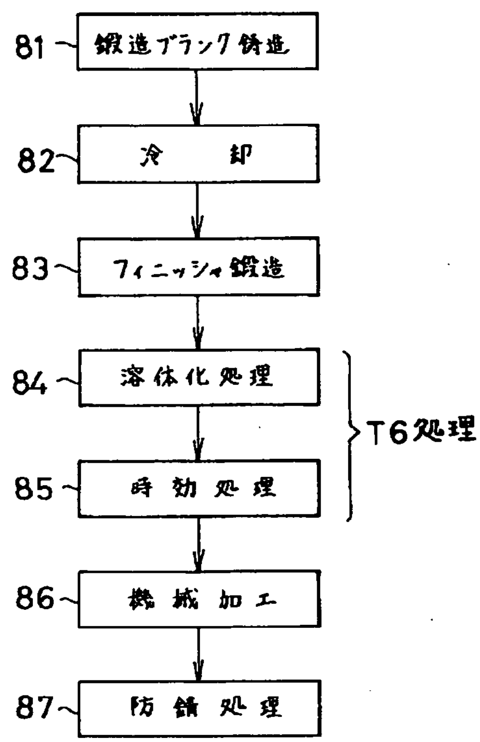


S1…第1の工程（鋳造工程）　S2…第2の工程（加熱処理工程）
S4…第4の工程（鍛造工程）　S6…第6の工程（時効処理工程）

【図7】



【図8】



フロントページの続き

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